

AEROSPACE RECOMMENDED PRACTICE

ARP492™

REV. C

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Superseding ARP492B

Aircraft Engine Fuel Pump Cavitation Endurance Test

RATIONALE

ARP492C has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

- 1.1 This SAE Aerospace Recommended Practice (ARP) defines procedures for testing aircraft engine fuel pumps for the purpose of determining their resistance to deterioration, during steady state endurance test, while receiving MIL-T-5624 Grade JP-4 fuel as a homogenous mixture of gas and liquid expressed as a ratio of vapor volume to liquid volume (V/L).

If any of the above conditions do not apply, refer to Section 2.

- 1.2 The procedure recommended herein is based on experience gathered by a number of laboratories conducting component qualification tests to MIL-E-5009, currently MIL-E-5007. It is intended to produce a uniform reproducible steady state test condition for fuel pump cavitation testing as required by various military engine specifications.

- 1.3 This test is NOT intended to establish altitude, climb rate, starting, or other transient performance of the article tested.

1.4 PURPOSE:

- 1.4.1 This procedure is intended to apply to all pumps downstream of engine inlet.
- 1.4.2 The procedure will be defined in terms of recommended test setups and recommended testing methods.
- 1.4.3 Two methods of determining V/L are provided.

CAUTION: Operation at low line velocities may result in nonhomogeneous flows and cause erratic or incorrect readings.

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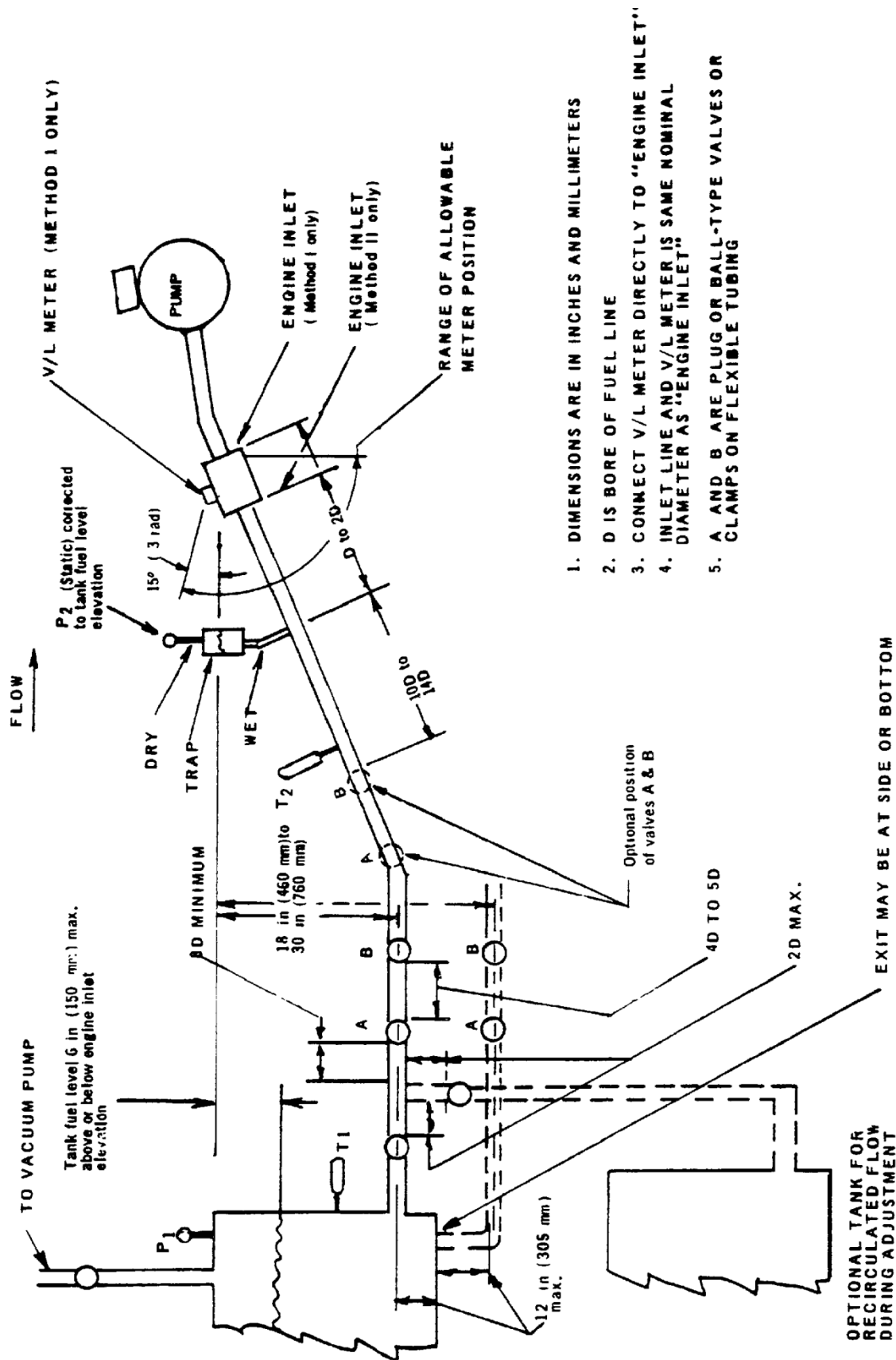
- 1.4.3.1 **Method I - V/L Meter:** When using this method, the vapor-to-liquid ratio is sensed in a measuring section installed in inlet line upstream of the pump as shown in Figure 1. The vapor-to-liquid ratio is assumed to be the indicated volume flow rate vapor-to-liquid ratio and is read out as V/L on a meter dial.
- 1.4.3.2 **Method II - V/L Calculation:** This method assumes that an equilibrium mass flow rate of dissolved air evolves from the flowing air saturated liquid fuel in accordance with Henry's Law for solution of gases in liquids. The volume flow rate vapor-to-liquid ratio is then calculated from the mass flows in accordance with Dalton's Law of Partial Pressures, the Perfect Gas Law and the liquid fuel thermal expansion behavior. The necessary calculations are described in Appendix A.

CAUTION: At low pump inlet pressures and/or high fuel temperatures, special care must be taken to obtain accurate readings of the test data that enter the V/L calculation. As can be seen from the V/L equation in Appendix A, a primary factor in the V/L calculation is the ratio of two pressure differentials measured during the test. If these pressure differential are small, as is the case when the tank pressure, P_1 (and, therefore, the pump inlet pressure P_2) is close to the absolute true vapor pressure of the fuel, P_{TVP} , even small errors in the measurements will cause large errors in the calculated value of V/L. A good practice in this connection would be the inclusion of note(s) on the test sheet calling attention to data points taken at low values of $(P_1 - P_{TVP})$ together with the attendant estimated possible error in the calculated V/L resulting from measurement errors.

- 1.4.3.3 **Recommended V/L Meters:** Recommended V/L meters are listed in Appendix B.
- 1.5 Within this document the term "pump inlet" shall define the fuel inlet port of the complete system to be tested. If lines or other components are placed upstream of the inlet of the actual pumping component by specific test requirement, such as to provide an engine inlet, they shall be part of the complete system to be tested.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. In the event of conflict between the text of this specification and the references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.



1. DIMENSIONS ARE IN INCHES AND MILLIMETERS

2. D IS BORE OF FUEL LINE

3. CONNECT V/L METER DIRECTLY TO "ENGINE INLET"

4. INLET LINE AND V/L METER IS SAME NOMINAL DIAMETER AS "ENGINE INLET"

5. A AND B ARE PLUG OR BALL-TYPE VALVES OR CLAMPS ON FLEXIBLE TUBING

FIGURE 1 - Test System

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AIR1326 Aircraft Fuel System Vapor-Liquid Ratio Parameter

ARP4024 Aircraft Engine Fuel Pump Net Positive Suction Pressure Performance Test (For low inlet pressure conditions which maintain the fuel in liquid form rather than a mixture of gas and liquid)

ARP4026 (DRAFT) Aircraft Engine Fuel Pump Special Fuels Cavitation Endurance and Net Positive Suction Pressure Performance Tests (For fuels other than MIL-T-5624 GRADE JP-4 fuel)

ARP4028 Aircraft Engine Fuel Pump Two Phase (Slugging Flow) Inlet Performance Test (For when the gas and liquid mixture is NOT a homogenous solution)

3. GENERAL REQUIREMENTS:

3.1 Fuel:

MIL-T-5624, Grade JP-4

3.1.1 Fuel Temperature:

- a. T_1 in supply tank: ± 1 °F (0.5 °C) of T_2 at the pump inlet
- b. T_2 at pump inlet: In accordance with the specific test requirement

3.1.2 Fuel Pressure:

- a. P_1 at fuel surface in supply tank: In accordance with the specific test requirement
- b. P_2 at pump inlet: Depressed below P_1 as required to produce the required V/L
- c. P_3 at pump discharge: In accordance with the specific test requirement, which typically will be the engine fuel system pressure required for the specified metered flow

3.1.3 Fuel Flow: System discharge and pump bypass flows shall be in accordance with the specified test requirements.

3.2 Inlet V/L Condition:

In accordance with the specific test requirements.

3.3 Duration of Endurance Test:

In accordance with the specific test requirements.

3.4 Pump Speed:

In accordance with the specific test requirement and, in general, will be an intermediate rated speed for the pump application.

4. DETAIL REQUIREMENTS:

4.1 Test Setup:

The equipment should be in accordance with Figure 1 subject to the limitations provided herein.

4.1.1 Fuel Tanks:

4.1.1.1 Shape of the tank is optional.

4.1.1.2 Insulation of the tank is optional. During cavitation test, the temperature difference between T_1 and T_2 should not exceed 1 °F (0.5 °C).

4.1.1.3 The minimum quantity of fuel shall be a volume equivalent to the system discharge flow for 2 min plus 15 gal (57 L). The maximum quantity of fuel shall be a volume equivalent to the system discharge flow for 5 min plus 15 gal (57 L). The system discharge flow shall be as defined by 3.1.3. The tank volume shall be at least 1.1 times the fuel volume.

4.1.2 Inherent Pressure Loss: The pressure loss from P_1 to P_2 should not exceed 2 in (50 mm) Hg at the test flow rate with the inlet line throttle valve(s) fully open.

4.1.3 Downstream Test Equipment:

4.1.3.1 A pump bypass line and valving may be provided as necessary to control system discharge flow in a manner consistent with the pump/control installation for the applicable engine.

4.1.3.2 Any other elements of the engine fuel system downstream of the pump which have an effect on the pump inlet conditions should be simulated.

4.1.3.3 Care should be taken to assure that the tank return flow is returned below the fuel surface and does not interfere with the tank to inlet line flow. The tank return point should be as isolated as possible from the tank to inlet connection and under no condition closer than 6.0 inch (150 mm) to the tank to inlet connection.

4.1.4 Additional Test Equipment: All necessary devices for testing, other than already described, may be placed in the test system as required other than in the inlet line.